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Research on Main Constraints in Sustainable Development of China Oil-Gas Upstream Industry

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Abstract

Though the long term exploration and development of China oil and gas resources, the yield and consumption have been increasing, but there are also many problems, including low grade oil reserve account for large percent in the future oil-gas replacement reserve, subtle reservoir exploration measures are immature, reservoir monitoring and management level need to be improved, oil-gas exploration and development advanced technologies are shortage, and so on. so, it must fully understand to these many problems in China oil-gas resources exploration and development, moreover, the effective implementation and completion our country oil-gas resources development targets must depend on the reasonable planning. This article is based on the analysis to present China oil-gas reserve, and point out that the current our country oil-gas resources station and problems in oil-gas resources exploration, development and utilization, meanwhile, the relative suggestion are put forward.

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1. Instruction

Oil and petrification is nation economic base infrastructural industries, oil is the “ industries blood”, moreover, resources is the original of oil and petrification. Oil industry technologies are desity, its development need the technologies advance, especially in this decade, global oil technologies have entered the advanced deveopment stage, the upstream technologies advance are extraordinary activty, research,development and application to advanced technologies have become the main methods to improve the core competitiveness and seek greater development in global oil corporations. The advance of technologies to reduce the exploration and development cost play the irreplaceable huge role. According to statistics, since the application and dissemination of high-new technologies, the world exploration and development average cost dicline 60%, meanwhile, the proved reserve increases 60%.

2. China oil-gas resources present situation

According the 2004 NDRC and Ministry of Land and Resources new round country oil-gas resources evaluation results, China present owns conventiional oil resource $1040 \times 10^8 \text{t}$, rate of proved is 38.9%; conventional natural gas resource is $420000 \times 10^8 \text{m}^3$, proved rate is 23%; in the unconventional oil resources the oil-sand oil is $59.7 \times 10^8 \text{t}$, proved rate is 47%, shale oil is $476 \times 10^8 \text{t}$,poved rate is 5.7%; in the unconventional gas, the coalbed methane is $3.81420000 \times 10^8 \text{m}^3$, rate of proved is 30%. Up to the end of 2008, China remaining oil vision resources quatity is $799 \times 10^8 \text{t}$, natural gas resources is $49.6 \times 10^{12} \text{m}^3$ ^[1]. Although the Resources enough, China per capita production is not abundant. China per capita oil amount is only 1/10 world average level.

since 1993, our country becames to oil importer, the oil imports increased gradually year by year, by the end of 2008, the oil imports is $17889.3 \times 10^4 \text{t}$, the external dependence increased from 26.7% in 2000 to 49.5% in 2008, even it is beyond 50% in 2009,it is to forecast that with the domestic economic development steadily and more fasterly, the demand still increasing, meanwhile, the demand gap also further expansion,if the situation is not be controlled by some measures, the oil consumption requirement will reach to $5 \times 10^8 \text{t}$ ^[2].China economy still keeps high-speed, the requirement to energy especially oil will further expansion, oil external dependence may be beyond 60% or higher. This is an oil security fire line which can seriously affect the China economy and society development or even the world energy and oil supply-demand relationship. At present, China is the fifth oil-gas production country in the world, from the oil-gas production distributed area, the East is the main oil contribution zoon to China, and the natural gas is the Middle. For the past few years, the Middle and Western parts develop more quickly. They will become China oil-gas main contribution areas^[3].

3. The main constraints in sustainable development of china oil-gas upstream industry

3.1. Low grade oil reserve account for large percent in the further oil-gas resources replacement reserve.

The exploration of China low grade oil has been pay enough attention, according to the new turn oil-gas evaluation, the resources quantity of China marginal oilfield account for half of the total resources^[4], low grade oil development degree is increasing year by year. The DaQing, LiaoHe, ShengLi, ChangQing oilfield local in the Middle, western, eastern, their low grade resources have become the important parts of oil-gas production.

The low grade oil reserve include two kinds^[5,6], the first kind is reservoir naturally formed, such as undeveloped marginal reservoir, complex little block reservoir, thin bed, ultra-heavy oil, low abundance, deep layer and low permeability reservoir, thereinto, the low permeability reservoir and heavy oil

reservoir is the main low grade reservoir; the other kind is manufacture, the remaining resources after oilfield long time development, the water cut in reservoir is high, individual well yield is low, the cost is high, recovery difficulty is large, no economical profit, it is similar to the tail in solid mineral.

There is no unified data to the proportion from many scholars about the naturally forming low grade reserve in the China oil geology reserve ^[7]. Cha Quanheng^[8] think the low grade resources is 50% in China oil resources, there is about 40×10^8 t low grade reserve is undeveloped, thereinto, low permeability reservoir reserve is 72.3×10^8 t, which account for 30.9%; heavy oil reserve is 46.7×10^8 t, which is about 20%. The percent to low grade reserve in total reserve of Songliao, Erdos, Junggar three large basins are 24%, 80%, 62% respectively, by the end of 2003, the producing ratio in the three basins is 50%. Oilfield in the eastern China have enter the high water cut period, and the degree of reserves recovery is different, from around 10% to 40%, the average is less than 30%, remaining resources is above 70×10^8 t. The potential is large. If the recovery can be enhanced by all kinds of high-tech, every one percent corresponding to 7000×10^4 t, so the low grade oil reserve has great significance in China oil-gas reserve and production structure, even can further stimulate yield.

3.2. Subtle reservoir exploration measures are immature.

In exploration, the subtle reservoir is meaning that the reservoir which is difficult to be distinguished or found, in trap, it is meaning that formation, lithologic trap and atectonic genesis buried hill trap whose found difficulty and the risk of exploration is higher than structural trap.

The land facies lake basins in our country have the characteristic that the types of reservoir sand body are rich, deposit lithology physical property change quickly, sand body heterogeneity is strong, land facies water overlapping, offlapping phenomenon is frequent, palaeogeomorphology fluctuate is large, these characteristic can impel to form the subtle reservoir with overlapping, lithologic and palaeogeomorphology trap, meanwhile, these also determine the characteristic that the potential and difficulty of land facies subtle reservoir exploration are coexisting. Little sand body, thin formation, buried hill, igneous rock etc geological body account for larger and larger proportion in prospecting target.

From the 1990's, the exploration has enter oil-gas exploration period whose main target is formation lithologic trap, for example, the 90% found oil-gas reserve in Erdos basin exists in the land lithologic trap, as well as Junggar basin is 70%-80%, Liaohe depression is 50%-60%, Songliao basin is above 30%, especially the past more than a decade, the proved reserve in land lithologic trap has exceed that in structural trap and become the main exploration reservoir type^[9].

Because of the inherent complexity to subtle reservoir, present geological cognition and exploration technologies can not much satisfied with the need of accurate exploration, this is manifested by under:

- There is not enough cognition to subtle reservoir distribution regularity;
- There is not enough cognition to forming mechanism of subtle reservoir;
- Because present technologies precision level is low, so the difficulty to accurately predicting the strong heterogeneity of subtle reservoir is large, this is the bottleneck to restrict the exploration benefit.

3.3. Reservoir monitoring and management level need to be improved

Study remaining oil distribution for the core is the main mission to reservoir monitoring and management mission in the oilfield development middle and late periods, fully use the static state and dynamic data to research the 3-D distribution of interborehole formation parameters and reservoir parameters in the reservoir zone, as well as the dynamic change of formation parameters, fluid properties and distribution, then establish the fine reservoir attribute quantitative model, and remaining oil distribution model from further researching water (gas/vapor)/ oil displacement rule, remaining oil

forming mechanism and distribution rule, all of above are to provide accurate geological references for reservoir subsequent adjustment, tapping the latent power, and tertiary recovery.

In the domestic, present reservoir monitoring and management researching mainly include: (1) interborehole reservoir distribution and accurate reservoir geological model; (2) reservoir property dynamic change characteristic in development; (3) fluid property dynamic change characteristic in development; (4) remaining distribution characteristic, the key is establishing accurate reservoir geological model, then confirm the remaining oil distribution characteristic.

It is the strenuous duty that How to adopt corresponding reservoir monitoring and management measurements to domestic land facies strong heterogeneity complexity reservoir in different type, or different development period. From now on, the reservoir monitoring and management researching should pay enough attention to some under hands (development and applications): launch land facies accurate sequence stratigraphy theory and application researching, seek recognizable bed boundary; continue to spreading and improving archetypal geological model and geological knowledge base application in reservoir predicting; development and optimization of new logging technologies with series modeling algorithm; based on 3D seismic, further develop 4D seismic and multiwave seismic, then solve maturing field remaining oil distribution and predicting problems of complexity reservoir, such as thin formation, fractured reservoir, etc.

3.4. *“Go abroad” capacity and level is limited*

Since present politics is unstable, geological condition is complex or we enter as stranger in zone of cooperation China entered, the difficulties are large, besides, China is short of advanced and proprietary intellectual property rights soft, technologies and equipments, include deep water drilling ship, magnetic resonance imaging logging equipment, offshore seismic information processing soft, etc, all of these much restrict the ability and level to share global oil-gas resources.

3.5. *oil-gas advanced technologies much need to be improved*

In resent years, oil (gas) recovery technologies and equipment fields is closely connection with the need of oil development, to oilfield entire degradation, self-contained technologies and equipment about multiwell low yield, low abundance, low grade and production process requirement, high water cut oilfield comprehensive treatment, low permeability reservoir economical development, heavy oil reserve effective producing, natural gas effective development, ultra-deep and complex type reservoir oil recovery, completion, downhole operation and workover are forming, these measures enhanced maturing development effect, improved new proved reserve deliverability transform efficiency, stimulated every oil-gas field development level, the need of oil-gas field development can be satisfied fundamentally.

Maturing oilfields have enter extra-high water cut period, this is means that further enhance oil recovery is the history duty of petroleum engineering; low grade reserve becomes the main development target gradually, the economic and effective recovery technologies are urgent needs; “three-highs” gas reservoir scale development and new task has been propounded; heavy oil development has enter the “two highs” period, urgently need to change producing methods; horizontal well is as the main technology to change increasing way, its self-contained technologies are urgently need to resolved; case damage well proportion is always high, the repair technology difficulties is increased; offshore oil-gas successively are placing on production, petroleum engineering technologies preparation is not enough.

The main development trend of further oil (gas) recovery engineering technologies equipments include: artificial lift method develop towards deep well, high pressure, long strokes, frequency of stroke, long life; completion technologies develop towards intelligentization, automation, integration, which can

achieve real time reservoir and borehole data monitoring; oil-gas well designing develop towards integration system; oil-gas well control develop from ground control, interfere operation to downhole intelligent control, non-interference operation; natural gas recovery develop towards fire resistant, pressure resistant, corrosion resisting, long life, high dependability, intelligentization; heavy oil recovery develop towards electrothermal steam; the main development direction of offshore oil recovery is deep water, large scale, design optimization, mating advanced; the key technologies of digitization oilfield—remote measuring, visualization, and intelligent drilling technologies are need to make a breakthrough.

4. Countermeasures and treatments

From several decades development, our country oil-gas upstream technologies have get a great advance, a series technologies difficulties also have been solved, as well as a few dominant techniques and feature are at the world leading level. However, contrasts to world advanced level, our comprehensive techniques level still falling behind, and the main body technologies have large gap with advanced countries, which directly affect the cost down of exploration and development and benefit rising. If there is no significant breakthrough in techniques, the large cost down can not be achieved. So, we must further develop advanced techniques, complete oil-gas up stream technologies leaped development, stimulate oil-gas upstream businesses sustainable development by technologies advanced.

We should keep a foothold in the domestic, stabilize the oil-gas exploration and reserve quantity increasing, enforce our country oil-gas the ability of initiative exploration, development, supply. China oil-gas development and utilization capacity is lower, which is proven by the low ratio of proven oil-gas, oil-gas recovery, oil-gas transformation and oil-gas utilization. The reasons are so many, the main reason in these are China remaining oil-gas resources occurrence environment is complex, as well as the advanced theories and technologies to develop and utilize the complex oil-gas resources are short, how to solve these problems is to strongly develop innovation talents.

Change thinking timely. Innovatively develop low grade resources exploration technologies. With the oil-gas exploration task sustained proceeding, the degree of exploration is rising, the trend change from conventional oil-gas resources to unconventional resources is inevitable. So, we should be earlier to recognize and plan low grade and unconventional oil-gas resources development and utilization, which is the inevitable road to ensure our country oil-gas resources security and stable supply.

Urgently need to develop talents with international vision, positively participate in the world oil-gas development and utilization. Whether at present or long term, the measurements must be positively carried out to improve the capacity and level of China share global oil-gas resources. Share international energy resources, diversification import, explore and utilize overseas oil-gas resources is the important supplement and inevitable choice of domestic oil-gas supply.

Positively develop numerous talents to research save oil and increasing efficiency of renewable substitution energy. As the important substitution energy, unconventional oil-gas resources development and utilization have extraordinary strategy significance, China oil-gas industry core change to unconventional oil-gas only is based on time. Developing our country unconventional energy need to solve the several following issues: make the economical supporting policies which are superior to conventional oil-gas policies to enforce unconventional oil-gas market competitive power; enhance unconventional oil-gas base theory research, seek high quality resources; liberate and reclaim thinking. Optimize present technologies, develop characteristic techniques, and quicken unconventional oil-gas exploration-development; accelerate shale gas, gas hydrate integrated evaluation. Develop synthetical utilization techniques, relieve the environment pressure. During develop unconventional oil and gas, dispose sewage, waste gas, waste residue, adopts various ways to synthetically utilize these waste, the waste can change to treasure. Protect environment and walk the sustainable development road.

5. Conclusions

In a word, our country oil-gas industry upstream techniques field has been faced with many questions form the economy and society, international and domestic and so on. Meanwhile, oil-gas upstream techniques field self-development also has a series of technologies difficulties. All of the techniques difficulties have become the key question of restricting oil industry upstream development. At one hand, we should as soon as possible to research and import overseas key technologies, depend on techniques improvement to get more benefit,; on the other and, we should as quickly as possible to reduce the gap with the world advanced level, and make us be at the more initiative and positive position, these can bring us more business chance in the larger field.

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